

## Claims

### What is claimed is:

1  
1 1. A fuel cell power plant (110, 210, 310, 410)  
2 including in combination, a fuel cell stack assembly  
3 (CSA) (12) having an anode region (14), a cathode region  
4 (16), and an electrolyte region (18) intermediate the  
5 anode and cathode regions; a fuel processing system  
6 (FPS) including combustion-supported reaction means  
7 (20, 120) for receiving a supply of fuel (46, 46', 48)  
8 and an oxidant stream (124, 224, 324, 424) and for  
9 providing a hydrogen-rich fuel stream (22) to the anode  
10 region (14); a source of oxidant (26); a primary energy  
11 recovery device (ERD) (30) having adjacent source (32)  
12 and sink (34) channels separated by an enthalpy  
13 exchange barrier (36) for the transfer of heat and  
14 moisture therebetween; a further energy recovery device  
15 (ERD) (50) having means (132, 134, 136) for receiving  
16 gas and liquid and flowing at least the gas  
17 therethrough in proximity with the liquid for the  
18 transfer of heat and moisture therebetween to regulate  
19 the dew point of the gas; a source of water (52); at  
20 least one of the combustion-supported reaction means  
21 (20, 120), the cathode region (16), and the anode  
22 region (14) having an exhaust flow (42, 44, 48, 148)  
23 for providing an exhaust gas stream (28, 128); and  
24 wherein the oxidant source (26) is operatively  
25 connected to flow through at least the sink channel of  
26 the primary ERD (30) to provide the oxidant stream  
27 (124, 224, 324, 424) supplied to at least the  
28 combustion-supported reaction means (20, 120), the  
29 exhaust gas stream ( 28, 128 ) is operatively connected  
30 to flow through at least the source channel of the  
31 primary ERD (30), the water source (52) is operatively  
32 connected to provide the liquid to the further ERD  
33 (50), and the further ERD (50) and one of the source

34 channel (32) and the sink channel(34) of the primary  
35 ERD (30) are serially connected (26', 28', 126',  
36 128')for gas flow therethrough, such that the  
37 regulation of the dew point of the gas flowing through  
38 the supplemental ERD (50) by the water in the  
39 supplemental ERD (50) operates to regulate, at least  
40 indirectly, the dew point of the oxidant stream (124,  
41 224, 324, 424) supplied to at least the combustion-  
42 supported reaction means (20, 120).

1     **2.** The fuel cell power plant (110, 210, 310, 410) of  
2 claim **1** wherein the further ERD (50) is upstream of the  
3 primary ERD (30) relative to the gas flow therethrough,  
4 the exhaust gas stream (28, 128) flows through the  
5 further ERD (50), and the regulation of the dew point  
6 of the oxidant stream (124, 224, 324, 424) is indirect.

1     **3.** The fuel cell power plant (110, 210, 310, 410) of  
2 claim **1** wherein the primary ERD (30) is upstream of the  
3 further ERD (50) relative to the gas flow therethrough,  
4 oxidant from source (26) flows through the further ERD  
5 (50), and the regulation of the dew point of the  
6 oxidant stream (124, 224, 324, 424) is direct.

1     **4.** The fuel cell power plant (110, 210, 310, 410) of  
2 claim **1** wherein the oxidant stream (124, 224, 324, 424)  
3 applied to the combustion-supported reaction means (20,  
4 120) is also applied, in parallel, to the cathode  
5 region (16).

1     **5.** The fuel cell power plant (110, 210, 310, 410) of  
2 claim **1** wherein the combustion-supported reaction means  
3 (20) comprises a catalytic steam reformer (40) and

4     separate burner (38), and the burner (38) has an  
5     exhaust flow (42).

1     **6.** The fuel cell power plant (110, 210, 310, 410) of  
2     claim **5** wherein the cathode region (16) has an exhaust  
3     flow 44, the cathode exhaust gas flow (44) and the  
4     burner exhaust flow (42) being combined to form the  
5     exhaust gas stream (28).

1     **7.** The fuel cell power plant (110, 210, 310, 410) of  
2     claim **1** wherein the combustion-supported reaction means  
3     (120) comprises a reformer (120) structured for  
4     integral combustion therewithin.

1     **8.** The fuel cell power plant (110, 210, 310, 410) of  
2     claim **7** wherein the reformer (120) is from the group  
3     consisting of an autothermal reformer and a catalytic  
4     partial oxidizer.

1     **9.** The fuel cell power plant (110, 210, 310, 410) of  
2     claim **7** wherein the anode exhaust flow (148) comprises  
3     a partly-depleted hydrogen gas stream, and the cathode  
4     exhaust flow (44) and the anode exhaust flow (148) are  
5     combustively reacted in a burner (60) to provide the  
6     exhaust gas stream (128).

1     **10.** The fuel cell power plant (110, 210, 310, 410) of  
2     claim **1** wherein the further ERD (50) comprises adjacent  
3     liquid (132) and gas (134) channels separated by an  
4     enthalpy exchange barrier (136), the gas flows through  
5     the gas channel (134), the water flows through the  
6     liquid channel (132), and the transfer of heat and  
7     moisture therebetween is via the enthalpy exchange  
8     barrier (136).

1     **11.** The fuel cell power plant (110, 210, 313, 410) of  
2     claim **10** wherein the enthalpy exchange barrier (36,  
3     136) in each of the primary ERD (30) and the further  
4     ERD (50) comprises a fine pore saturator medium.

1     **12.** The fuel cell power plant (110, 210, 310, 410) of  
2     claim **1** wherein the temperature of the water supplied  
3     to the further ERD (50) regulates the dew point of the  
4     oxidant stream (124, 224, 324, 424) supplied to at  
5     least the combustion-supported reaction means (20,  
6     120).

1     **13.** A fuel cell power plant (110, 210, 310, 410)  
2     including in combination, a fuel cell stack assembly  
3     (CSA) (12) having an anode region (14), a cathode region  
4     (16), and an electrolyte region (18) intermediate the  
5     anode and cathode regions; a fuel processing system  
6     (FPS) including combustion-supported reaction means  
7     (20, 120) for receiving a supply of fuel (46, 46', 48)  
8     and an oxidant stream (124, 224, 324, 424) and for  
9     providing a hydrogen-rich fuel stream (22) to the anode  
10    region (14); a source of oxidant (26); a primary energy  
11    recovery device (ERD) (30) having adjacent source (32)  
12    and sink (34) channels separated by an enthalpy  
13    exchange barrier (36) for the transfer of heat and  
14    moisture therebetween; a further energy recovery device  
15    (ERD) (50) having adjacent liquid (132) and gas (134)  
16    channels separated by a fine pore saturator medium  
17    enthalpy exchange barrier (36, 136) for the transfer of  
18    heat and moisture therebetween to regulate the dew  
19    point of the gas flowing in the gas channel (134) as a  
20    function of the liquid; a source of water (52); at  
21    least one of the combustion-supported reaction means  
22    (20, 120), the cathode region (16), and the anode  
23    region (14) having an exhaust flow (42, 44, 48, 148)  
24    for providing an exhaust gas stream (28, 128); and

25 wherein the oxidant source (26) is operatively  
26 connected to flow through at least the sink channel of  
27 the primary ERD (30) to provide the oxidant stream  
28 (124, 224, 324, 424) supplied to at least the  
29 combustion-supported reaction means (20, 120), the  
30 exhaust gas stream ( 28, 128 ) is operatively connected  
31 to flow through at least the source channel of the  
32 primary ERD (30), the water source (52) is operatively  
33 connected to flow at a controlled temperature through  
34 the liquid channel (132) of the further ERD (50), and  
35 the gas channel (134) of the further ERD (50) and one  
36 of the source channel (32) and the sink channel(34) of  
37 the primary ERD (30) are serially connected (26', 28',  
38 126', 128')for gas flow therethrough, such that the  
39 regulation of the dew point of the gas flowing through  
40 the supplemental ERD (50) by the temperature of the  
41 water in the supplemental ERD (50) operates to  
42 regulate, at least indirectly, the dew point of the  
43 oxidant stream (124, 224, 324, 424) supplied to at  
44 least the combustion-supported reaction means (20,  
45 120).

1 **14.** In a fuel cell power plant (110, 210, 310, 410)  
2 including in combination, a fuel cell stack assembly  
3 (CSA)(12) having an anode region (14), a cathode region  
4 (16), and an electrolyte region (18) intermediate the  
5 anode and cathode regions; a fuel processing system  
6 (FPS) including combustion-supported reaction means  
7 (20, 120) for receiving a supply of fuel (46, 46', 48)  
8 and an oxidant stream (124, 224, 324, 424) and for  
9 providing a hydrogen-rich fuel stream (22) to the anode  
10 region (14); a source of oxidant (26); a primary energy  
11 recovery device (ERD) (30) having adjacent source (32)  
12 and sink (34) channels separated by an enthalpy  
13 exchange barrier (36) for the transfer of heat and  
14 moisture therebetween; at least one of the combustion-

15 supported reaction means (20, 120), the cathode region  
16 (16), and the anode region (14) having an exhaust flow  
17 (42, 44, 48, 148) for providing an exhaust gas stream  
18 (28, 128), the exhaust gas stream ( 28, 128 ) being  
19 operatively connected to flow through at least the  
20 source channel (32) of the primary ERD (30); and  
21 wherein the oxidant source (26) is operatively  
22 connected to flow through at least the sink channel  
23 (34) of the primary ERD (30) to provide the oxidant  
24 stream (124, 224, 324, 424) supplied to at least the  
25 combustion-supported reaction means (20, 120), the  
26 method of regulating the dew point of the oxidant  
27 stream (124, 224, 324, 424) supplied to at least the  
28 combustion-supported reaction means (20, 120)  
29 comprising the step of:

30 a) passively condensing (50) moisture from a gas  
31 stream (28, 128, 26', 126'), the gas stream being one  
32 or the other of:

- 33 i) the oxidant stream (26', 126') downstream of  
34 the flow of the oxidant source (26) through  
35 the sink channel (34) of the primary ERD  
36 (30), thereby to effect direct regulation of  
37 said dew point; or  
38 ii) the exhaust gas stream (28, 128) upstream of  
39 the flow of the exhaust gas stream (28',  
40 128') through the source channel (32) of the  
41 primary ERD (30), thereby to effect indirect  
42 regulation of said dew point.

1 **15.** The method of claim **14** wherein the step of  
2 passively condensing (50) moisture from a gas stream  
3 (28, 128, 26', 126') comprises flowing (134) said gas  
4 stream in proximity with a liquid (52, 132) in a manner  
5 to effect a transfer (136) of heat and moisture between  
6 said liquid and gas streams as a function of at least

7 the temperature of said liquid relative to said gas  
8 stream.

1 **16.** The method of claim **15** wherein the liquid (52) is  
2 water and the temperature of said water is regulated to  
3 effect the condensation needed to regulate the dew  
4 point of the oxidant stream (124, 224, 324, 424)  
5 supplied to at least the combustion-supported reaction  
6 means (20, 120).

1 **17.** The method of claim **15** wherein the liquid is water  
2 (52) and the step of passively condensing moisture from  
3 a gas stream comprises flowing (134) the gas stream  
4 (28, 128, 26', 126') and flowing (132) the water (52)  
5 along respectively opposite sides of a porous enthalpy  
6 exchange barrier (136) of a supplemental energy  
7 recovery device (50) to effect said transfer of heat  
8 and moisture.

1 **18.** The method of claim **15** wherein the liquid is water  
2 (52) and the gas stream from which moisture is  
3 passively condensed (50) comprises the exhaust gas  
4 stream (28, 128) upstream of the flow of the exhaust  
5 gas stream (28', 128') through the source channel (32)  
6 of the primary ERD (30), thereby to effect indirect  
7 regulation of said dew point.